

REMARKS

1. Specification Amendment

The specification has been amended to update references to U.S. patent applications and issued patents. No new matter has been added.

2. Status of Claims

Claims 1-10, 18, 21-29, 34-37, 39-41 and 43-46 have been canceled, claims 11-15, 19, 20, 31-33 and 38 have been amended and claims 11-17, 19, 20, 30-33, 38 and 42 remain pending in the application.

Support for the amendments to claim 11 can be found in the claims as previously presented and in the specification at page 19, last paragraph.. Claims 12-17, 19, 20, 30-33, 38 and 42 are amended to provide proper antecedent basis for the claim elements. No new matter has been added.

3. Objections to Information Disclosure Statement

In the Final Office Action, the Examiner states that an Information Disclosure Statements (IDS) filed 06/01/2007 allegedly fails to comply with the provisions of 37 CFR 1.97, 1.98 and MPEP §609. Specifically, the Examiner notes that dates of publication for two references were not provided on Form PTO-1449, that a legible copy of foreign patent document GB 2 210 619 was not provided, and that a concise explanation of foreign patent document DE 4306119 (a non-English language document) was not provided. In view thereof, Applicant submits the following along with a Supplemental Information Disclosure Statement appended hereto and made a part of this paper.

Firstly, as is shown in a marked-up version of the originally submitted Form PTO-1449, with the Examiner's initials present (appended hereto and made a part hereof), dates (e.g., a month and year of publication) were provided for the references noted by the Examiner. For example, an article entitled "Noise and Vibration Control Engineering Principles and Applications" by Beranek et al. shows a publication date of "Aug. 1992" on the form PTO-1449, and similarly, an article entitled "SONAR Gets into the Flow" by Gysling et al. shows a publication date of "January 2004".

Secondly, the Supplemental IDS now includes a legible copy of patent document GB 2 210 619 and, in English, the title, abstract, and drawings of the German reference DE

4306119 as well as a concise explanation of the relevance of the reference, in accordance with 37 CFR 1.98(a)(3).

In view of the foregoing, Applicants request that the Examiner consider the articles originally submitted in the IDS of 01 June 2007, consider the copy of British reference GB 2 210 619 now presented and consider German reference DE 4306119, and further entered these references in the record of the present application.

4. Claim Rejections – 35 U.S.C. §102

Claims 1, 11-15, 17-21, 27-36, 38-40, 42, 43, 45, and 46 are rejected under 35 U.S.C. §102(b) as allegedly being anticipated by an IEEE article entitled "Sensing Turbulence Transit Time by Pulsed Ultrasound for Single-Phase Fluid Flow Measurement," by Harshal B. Nemade et al. (hereinafter "Nemade").

Claims 1, 18, 21, 27-29, 34-36, 39-40, 43 and 45 are canceled. Claim 11 has been amended to more clearly distinguish the present invention from Nemade.

Nemade discloses the measurement of fluid flow characteristics (turbulence) by the detection of tagging markers at two locations with regard to a pipe through which the fluid flow is directed. Sensors are used at the two locations to detect the tagging markers. The transit time of the tagging marker between the two locations is estimated using a cross-correlation function of $x(t)$ and $y(t)$ signals from the sensors. A simple arithmetic calculation is made to calculate the velocity of the flow from the sensor spacing and the transit time. Additionally, Nemade discloses that the measurements are made by only two pair of transducers (T1/T2 and T3/T4) at two location $x(t)$ and $y(t)$ separated by a length L . Finally, Nemade does not disclose an ultrasonic transmission frequency suited for volumetric flow measurement of a liquid phase fluid.

Accordingly, Nemade fails to disclose, teach, or suggest processing sensor signals by a spatial-temporal transformation to define a convective ridge from an x - t domain to a k - ω domain, the convective ridge representing a concentration of disturbances that convect with fluid flow, and determining the slope of at least a portion of the convective ridge to determine the flow velocity of the fluid, as now recited in Claim 11. On the contrary, Nemade utilizes cross-correlation which simply involves measuring the time it takes for ultrasonic beams to transit across a flow path at two axially displaced locations along the path of the flow and correlating variations in these times with properties of the flow. The present invention as

now recited in Claim 11, on the other hand, uses the spatial-temporal frequency content of time stationary sound fields and displays them using three-dimensional power spectra in which power is decomposed in accordance with specific spatial wave numbers and temporal frequencies (known as k - ω plots). On the k - ω plots, power is distributed in regions known as "convective ridges," the slopes of which indicate convective velocity. Using cross-correlation as in Nemade does not involve the use of spatial-temporal transformations to define the convective ridge from the x - t domain to the k - ω domain (known as k - ω processing) as recited in claim 11. Instead, Nemade uses the simple arithmetic calculation to determine flow velocity, and there is no display of three-dimensional power spectra in accordance with wave numbers and frequencies as there are in the generation of the k - ω plots. Accordingly, processing signals by spatial-temporal transformations to define a convective ridge from an x - t domain to a k - ω domain, the convective ridge representing a concentration of disturbances that convect with fluid flow, as recited in claim 11, is patentably distinct from the use of cross-correlation, as disclosed in Nemade.

Claim 11, as amended, further includes the limitation that the ultrasonic transmission frequency be at least 5 megahertz. As disclosed on page 19, last paragraph, for the measurement of a liquid, such as pure water, a configuration utilizing a transmission frequency of 5 megahertz provided excellent results. Although not disclosed in the present application, it has been learned that for a liquid phase, an ultrasonic transmission frequency of at least 5 megahertz provides superior results for the implementation of the present invention due to a number of factors, including better phase discrimination of the transmitted signal, higher signal to noise, and better performance for low flow rates.

Claim 11 has been further amended to include the limitations of claim 29 that the array of ultrasonic sensor pairs include 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 or 16 ultrasonic sensor pairs. It is respectfully submitted that not only does Nemade fail to disclose or suggest more than 2 pair of ultrasonic sensors, but that Nemade teaches away from more than 2 pair of ultrasonic sensors. As discussed above, Nemade discloses the use of two pair of ultrasonic sensors for the measurement of fluid flow characteristics (turbulence) by the detection of tagging markers at two locations with regard to a pipe through which the fluid flow is directed. The transit time of the tagging marker between the two locations is estimated using a cross-correlation function of $x(t)$ and $y(t)$ signals from the sensors. Nemade is measuring the transit time of a tagging marker between a first location $x(t)$ and a second location $y(t)$,

and therefore discloses only two pair of sensors, and there is no disclosure or suggestion to utilize more than two pair for the measurement disclosed by Nemade.

Because Nemade fails to disclose, teach, or suggest (1) utilizing more than two pair of sensors; (2) utilizing an ultrasonic transmission frequency of at least 5 megahertz, and (3) processing sensor signals by a spatial-temporal transformation to define a convective ridge from an $x-t$ domain to a $k-\omega$ domain, the convective ridge representing a concentration of disturbances that convect with fluid flow, and determining the slope of at least a portion of the convective ridge to determine the flow velocity of the fluid as now recited in independent Claim 11, Claim 11 is not anticipated by Nemade. For at least these reasons, Claim 11 as now written is deemed allowable. In view thereof, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of Claim 11.

Dependent claims, by definition, further define the subject matter of the independent claims from which they depend. Because Claims 12-17, 19, 20, 30-33, 38 and 42 depend from independent Claim 11, Claims 12-17, 19, 20, 30-33, 38 and 42 add recitations that further define the subject matter of independent Claim 11. Because Claim 11 as now written is believed to be allowable for at least the reasons presented above, Claims 12-17, 19, 20, 30-33, 38 and 42 are therefore also believed to be allowable. Consequently, Applicants respectfully request that the rejections of Claims 12-17, 19, 20, 30-33, 38 and 42 be reconsidered and withdrawn.

5. Claim Rejections – 35 U.S.C. §103(a)

Claim 16 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Nemade in view of U.S. Patent No. 6,609,069 to Gysling (hereinafter “Gysling”). The Examiner alleges that Nemade discloses a method and apparatus as discussed in the Office Action. The Examiner also notes that Nemade does not disclose the Capon algorithm. The Examiner further alleges that Gysling discloses using the Capon algorithm to have accurate estimate results and that it also would have been obvious to one of ordinary skill in the art at the time of the invention to modify Nemade to have the Capon algorithm as taught by Gysling in order to have accurate estimate results.

However, Gysling is not seen to cure the above described deficiencies in the application of Nemade to independent Claim 11, from which claim 16 depends. In view thereof, it is respectfully submitted that Claim 11 is allowable over the proposed combination

of Nemade and Gysling. Further, it is respectfully submitted that claims that depend from a claim that is non-obvious are themselves necessarily non-obvious. Because Claim 16 depends from Claim 11, and because Claim 11 as now written is asserted to be novel and non-obvious for the reasons presented above, Claim 16 is necessarily non-obvious. Applicants, therefore, respectfully submit that Claim 16 is allowable. Accordingly, Applicants respectfully request that the rejection of Claim 16 be reconsidered and withdrawn.

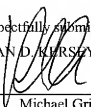
6. Conclusion

Applicants believe that the foregoing amendments and remarks are fully responsive to the Office Action and that the claims herein are allowable. An early action to that effect is earnestly solicited.

If the Examiner believes that a telephone conference with Applicants' attorneys would be advantageous to the disposition of this case, the Examiner is invited to telephone the undersigned.

Submitted herewith is a request for a three-month extension of time and the authorization to charge such fees to Deposit Account No. 50-0260, Order No. CC-0700, maintained by the undersigned attorney. Applicants believe that no further fees are due with the submission of this Amendment and the submittal of the Supplemental IDS appended hereto. If, however, any additional fees are in fact due with respect to this Amendment and Supplemental IDS, the Commissioner is hereby authorized to charge such fees to Deposit Account No. 50-0260, Order No. CC-0700, maintained by the undersigned attorney.

Respectfully submitted,
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